ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
Index Copernicus Value: 68 . 16
PubMed - National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 5, Issue –2, April - 2020, Page No. : 190 - 196

Radiation to the Thyroid Gland during Intra Oral Dental Radiography: The Need for Diagnostic Reference Level

[1]Agboje Anthonio Azuka, Radiology Radiography Unit, Living Word Mission Hospital Aba, Abia State, Nigeria

[2]Ebbi Donald Robinson , Department of Radiology, Rivers State University Teaching Hospital, Port Harcourt, Rivers State, Nigeria

[3]Uwa Onwuchekwa, Department of Internal Medicine, Abia State University, Aba, Nigeria

[4]Christian C. Nzotta, Department of Radiography and Radiologic Sciences, Faculty of Health Sciences and Technology, Nnamdi Azikiwe University, Nnewi Campus, Nigeria

Corresponding Author: Ebbi Donald Robinson, Department of Radiology, Rivers State University Teaching Hospital, Port Harcourt, Rivers State, Nigeria.

Citation this Article: Agboje Anthonio Azuka, Ebbi Donald Robinson, Uwa Onwuchekwa, Christian C. Nzotta, "Radiation to the Thyroid Gland during Intra Oral Dental Radiography: The Need for Diagnostic Reference Level", IJMSIR- April - 2020, Vol – 5, Issue -2, P. No. 190– 196.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Investigations of oral and dental pathologies do require the use of ionizing radiation. Notwithstanding the technique and the low radiation doses used, scatter radiation could be absorbed by close organs like the thyroid gland. The aim of the study is to evaluate the amount of scatter radiation that is absorbed by the thyroid glands during intraoral dental radiography which is geared towards obtaining a diagnostic reference level for intraoral dental radiography.

Materials and method: Prospective cross-sectional descriptive study design was adopted for the study from January to June 2018. 55 patients refereed for intra-oral radiographic examinations were evaluated. The Entrance Surfaces doses (ESDs) were evaluated using the thermoluminescent dosimeter chips (TLDs) which were placed at the level of the thyroid gland on the anterior aspect of the neck. It was held in position with an adhesive tape. The TLD chips were removed and sent for reading at the Radiation Dosimetric Laboratory of the Regional Centre for Energy Research and Training. SPSS windows version 22.0 statistical software was used to analyse collated data while a descriptive statistical tool was also used to determine central tendencies.

Result: The entrance surface doses (ESD) to the thyroid gland ranged between 0.11mGy to 4.46mGy with a composite mean ESD (±SD) of 1.11±0.95mGy. The mean ESD±SD for males and females were 1.08±0.89mGy and 1.15±1.07mGy respectively. There was no statistically significant difference seen between these means.

Conclusion: The radiation dose to the thyroid gland was lower than the documented threshold that could result in negative effect. However there is a need for a

diagnostic reference level for intraoral radiography with the aim of monitoring overexposure.

Keywords: Intraoral radiography, Thyroid gland, Entrance Skin Dose, Radiation dose, Thermolumiscent dosimeter, X-ray.

Introduction

Intraoral periapical technique is one of the commonly employed techniques in dental radiology [1, 2]. The technique is uses relatively low doses of radiation in evaluating oral and dental disorders such as traumas, dental caries, and periodontal lesions [1]. During the procedure the crown of the tooth to its apex, periodontal space and the surrounding bones are demonstrated [3]. The technique involves the use of radiographic film which is placed inside the mouth of the patient and then exposed to ionizing radiation by an X-ray machine [3,4].

The thyroid gland is an endocrine organ covered by pretracheal fascia and situated at the anterolateral aspect of the neck, the organ lies anterior to the thyroid and cricoid cartilages of the larynx in the visceral space and extends from the 5th cervical vertebra to the 1st thoracic verteberae. It is butterfly shaped and is composed of two lobes which are connected in the midline by a narrow isthmus [5]. The thyroid gland, is one of the most radiosensitive organs is frequently exposed to scattered radiation and occasionally to the primary x-ray beam during dental radiography [6].

It is documented by different authors that during dental radiography the risk of radiation induced carcinogenesis of the thyroid gland is very small wen compared with other diagnostic imaging techniques. However, some epidemiological studies have suggested an increase risk of thyroid tumours [7,8]. It is assumed that the risk of radiation induced damage is very low with intraoral radiography but there could be delayed somatic effects with low doses of x-radiation [8,9]. According to Zhang *et al.*, 2012 [9], increased risk of thyroid cancer is associated with dental radiography. Every radiation dose has the potential to cause a biologic damage or change in a tissue. This potential damage could be of serious consequences such as leukemia and cancer of the thyroid [6, 10. 11].

The need for dose optimization cannot be overemphasised. The measurement of the dose received by patients during intraoral radiography is a very pertinent factor in dose optimization, limitation and quality control. The determination of the radiation dose received by patients during intraoral radiography could be done by evaluating the entrance skin dose using thermoluminescent dosimeters (TLD) [3,11]. The ability to accurately measure the radiation dose received during intraoral radiography is very pertinent in radiation dose management [9]. An event of high dose indicates predisposition to higher health risk to the operator or recipient or both [12]. The main aim of radiological protection is to ensure that the investigation is performed with a radiation dose that is As Low As Reasonably Achievable [11, 13, 14].

Most of the dose measurement related surveys in Nigeria were carried using conventional radiographic examination with paucity of documentation relating to dental radiographic dosimetric survey [13].

According to International Commission on Radiation Protection [15] (ICRP) recommendations, diagnostic reference level (DRL) should be region, state and country specific. Meanwhile there is paucity of large scale studies in other to set a diagnostic reference levels in intraoral radiography [14]. Hence the study is aimed at evaluating the radiation dose to the thyroid glands during intraoral dental radiography as a means of

© 2020 IJMSIR, All Rights Reserved

setting a diagnostic reference level (DRL) and dose optimization in our region.

Materials and methods

A prospective cross-sectional descriptive study design was adopted for the study. The study was conducted for 6 months (from January to June 2018). Patients refereed from the dental clinic for intraoral periapical dental radiography at Living Word Mission Hospital, Aba, Abia State that satisfy the inclusion criteria were adopted for the study. The study is aimed at evaluating the amount of radiation to the thyroid glands during intraoral dental radiography using thermoluminescent dosimeters.

The sample size was derived from the target population using Taro Yamane formula [16]. The sample population, N was obtained from the number of patients that had intraoral periapical x-ray within the period of study. Hospital record revelled that 60 patients had dental radiological examination from January to June the previous year.

Hence, the sample population is 60.

n = 60/1.15 = 52

The sample size is fifty two (52). This was increased to fifty five (55) to have a good representative of the study population and increase the level of confidence.

Ethical Approval and Consent to participate

Ethical approval and consent to participate in the study was granted by the Faculty of Health Science and Technology Research Ethics Committee, in line with the Helsinki Declaration. The research was carefully explained to the patients and a written informed consent was obtained from each patient before the investigation.

Methodology

A Germany made wall mounted dental x=ray machines (AMS dental x-ray machine) manufactured 2010 and installed in the hospital in 2015 was used for the study. The AMS automatic dental x-ray machine has a digital sensor and a current calibration was used as a source of radiation exposure. The machine has a maximum Voltage of 70kVp and a tube current of 7mA. The machine has a Tube focus of 0.8mm (IEC) and a 20cm cone length Collimation.

A well calibrated radiation monitor (Radalert 100) was used to check the background radiation level in the dental clinic. The highest background radiation was 0.015mR/h (0.15mSv/h or 1.31mSv/year). The patient's weight and height were measured with standiometer and Hanzon emperor weighing scale.

Thermoluminescent dosimeters (TLD-100, Harshaw, USA) was used for the measurement of entrance skin dose. The TLD used were first annealed and calibrated (in order to remove residual data in them). The thermoluminescent dosimeters were then placed on the skin and held in place with an adhesive tape. After the examination the TLDs were carefully removed and sent though a protective bag to the Radiation Dosimetric Laboratory of the Regional Centre for Energy Research and Training for reading.

The variables obtained in the study were collated, documented in a tabular data sheet and analysed. Before exposure to ionizing radiation, the age, height, weight and BMI were obtained and documented. The analysis was done using Statistical Package for Social Sciences (SPSS) windows version 22.0 statistical software (SPSS Inc. Chicago, Illinois, USA), to obtain the mean, range and standard deviation (using descriptive statistics). The results obtained were presented in tables, graphs and charts.

A paired sample t-test was used to compare means between variables while Pearson correlation was used to test correlation between variables. A p-value of less

© 2020 IJMSIR, All Rights Reserved

than 0.05 was considered statistically significant for tests of correlation.

Results

35 participants out of the 55 were males while 20 (36.36%) are females. Male's age ranges from males 6.00-65.00years whereas the composite mean (±SD) age for males and females was 33.89 ±12.85years and 36.90 ±11.78years respectively. The BMI of participants ranges from 15.25-31.63 and 20.20-45.35 for males and females respectively. The composite mean (±SD) BMI was 25.40±5.44.

The entrance surface doses (ESDs) to the thyroid glands ranges from 0.11mGy to 4.46mGy with a composite mean (±SD) dose of 1.11±0.95mGy (see table 1). The mean (±SD) thyroid dose in females (1.15±1.07mGy) was slightly higher than that of males (1.08±0.89mGy) as shown in table 2. Age group 10-19years had the highest mean thyroid dose (2.46+1.82mGy) while age group 60-69 had the largest BMI (table 1). Thyroid dose correlation with anthropometric variables revealed that there were no significant statistical differences (see table 3).

Table 1: The overall mean entrance surface doses (ESDs) to the thyroid glands

Variables	N	Minimum Dose (mGy)	Maximum Dose (mGy)	Mean Dose (mGy)	BMI
AGE GROUP (YEARS)					
0-9	2	0.36	1.46	0.91+0.78	15.00+0.00
10- 19	3	0.42	3.92	2.46+1.82	17.67+0.58
20-29	11	0.35	1.67	0.74+0.48	24.75+4.39
30-39	22	0.11	4.46	1.19+1.03	26.25+4.12
40- 49	11	0.45	3.23	1.25+0.83	27.09+6.39
50-59	2	0.38	0.87	0.63+0.35	24.60+4.45
60-69	4	0.42	0.97	0.57+0.27	28.87+7.06
Total	55	0.11	4.46	1.11+0.95	25.40+5.44

Table 2: The mean entrance surface dose (ESD) to the parotid and thyroid glands in male and female patients

	Males		Female	
Variable	35 (63.64%)		20 (36.36%)	
	Range	Mean ± SD	Range	Mean ± SD
AGE (years)	6.00-65.00	33.89 ± 12.85	20.00-61.00	36.90 ± 11.78
BMI	15.25-31.63	23.67 ± 4.24	20.20-45.35	28.44 ± 6.05
Thyroid Dose (mGy)	0.35-3.92	1.08 ± 0.89	0.11-4.46	1.15 ± 1.07
P-value	0.921 (Male Thyroid Dose:1.08 ± 0.89 Female Thyroid Dos:1.15 ± 1.07)			
t-value	0.100 (Male Thyroid Dose:1.08 ± 0.89 Female Thyroid Dos:1.15 ± 1.07)			

Table 3: Thyroid doses with the patients' anthropometric variables

Parameters		AGE	BMI	WIEGHT	HEIGHT
Thyroid dose correlated with anthropometric variables	R-value	0.118	0.046	0.146	0.158
	P-value	0.389	0.738	0.291	0.255

Discussion

35 participants out of the 55 patients were males while 20 (36.36%) are females. Male's age ranges from males 6.00-65.00years whereas the composite mean (±SD) age for males and females was 33.89 ±12.85years and 36.90 ±11.78years respectively. The BMI of participants ranges from 15.25-31.63 and 20.20-45.35 for males and females respectively. The composite mean (± SD) BMI was 25.40±5.44. Age group 10-19years had the highest mean thyroid dose (2.46+1.82mGy) while age group 60-69 had the largest BMI. Thyroid dose correlation with anthropometric variables revealed that there were no significant statistical differences.

The result of the analyses revealed that the cumulative mean entrance surface dose (ESDs) to the thyroid glands in the patients was 1.11±0.95mGy. The values of the ESDs to the thyroid glands ranged from 0.11mGy to 4.46mGy. The results from this study were

© 2020 IJMSIR, All Rights Reserved

slightly higher than those from a study at the University College Hospital, Ibadan, Nigeria where results indicated that the entrance surface doses (ESD) ranged between 0.0447mGy to 0.3898mGy. In another study by Sheikh et al[10] to Evaluation of surface radiation dose to the thyroid gland during routine full-mouth intraoral periapical radiography using 120 subjects revealed a mean entrance surface dose of 10.93mRads (equivalent to 0.1093mGy). In the study by Sheikh et al[10] 10 IOPA (E speed films) and a digital pocket dosimeter (PD-4507) was used to measure the entrance surface dose. The mean value obtained in the present study was higher than that obtained the study by Sheikh et al [10] although the mean is within the range of values. The variation between this studies could be attributed to demographic pattern, sample population and calibration indices of the radiation monitoring device.

The result obtained in this study was also higher than the study by Mortazavi et al.[17], in 2004 to 'evaluate the Entrance Surface Dose Measurement On The Thyroid Gland In Orthopantomography: The Need For Optimization'. In the study by Mortazavi et al.[17], the overall mean ESD on the thyroid was 0.071±0.012mGy (ranged from 0.01 to 0.40mGy). The mean ESD in their study was obtained using 66kVp for 20 patients and 68 kVp in another separate 20 patients. The mean ESD (SD) was 0.072 ±0.019mGy, and 0.070±0.016mGy for the 66kVp and 68 kVp respectively. However, the result obtained in the present study was in accordance with a Spanish study using digital intraoral x-ray by Alcaraz et al [18] to evaluated the Dose Reference Levels in Spanish Intraoral Dental Radiology. Their study revealed a mean diagnostic reference level for adult patients undergoing intra oral radiography as 1.3mGy.

The mean entrance surface doses (ESDs) to the thyroid glands in female and male patients in the index study were 1.15±1.07mGy and 1.08±0.89mGy respectively. No significant difference between the entrance surface doses for males and females patients ($p>0.05$)

The ESD obtained in this study was also less in comparison to other references doses such as in the UK, with 2.5mGy reference dose for bitewing exposure at 70kVp using E-speed film and 5.0mGy at 50kVp[13] but fairly within the Canadian reference ESDs values of 1.09-1.44mGy for intraoral examinations at 70kVp [13] .

The disparities observed between the present study and others might be attributed to the type of intraoral machine used, cone length and positioning, as well as exposure conditions such as tube current, tube voltage, exposure time and focus film distance. The types, sensitivity and speed of films used and the placement and accuracy of TLDs may have also contributed to the observed disparity. Data collected from over 300 intraoral x-ray facilities using thermoluminescent dosimeters proposed a provisional reference level of 3.5mGy[19]. The entrance surface dose obtained in that study[19] is higher than that obtained in the present study.

According to Geijer, 2001 [20] ionizing radiation induced malignancies and lesions are said to a dose dependent phenomenon. The overall range of doses in this work was also far less than the 7mGy proposed reference level for diagnostic intraoral radiographies by International Atomic Energy Agency (IAEA) but falls within the range of 0.01 to 0.40mGy for the distribution of Entrance Skin Doses (ESDs) measured at the center of the beam on the patients' skin in intraoral radiography obtained by IAEA. Attempts are been made globally to ensure safety in radiation imaging

© 2020 IJMSIR, All Rights Reserved

modalities (eg dental radiography) by the use of digital systems, shields and fast films 13, 14].

Spearman correlation analysis was used to demonstrate the relationship between the entrance surface doses and the patients' anthropometric variables. The result showed that there was no significant positive correlation ($p>0.05$) between entrance surface dose and age and BMI. Spearman correlation analysis also demonstrated no significant positive correlation between the measured doses and some patients' anthropometric variables.

But the measured doses are much lower than the recommended international diagnostic reference levels by the International Atomic Energy Agency (IAEA) and similar studies in Canada, Iran and Korea. The disparities arising from this study and others might be explained to be due to the type of intraoral machine used, cone length and positioning, exposure conditions such as tube current, tube voltage, exposure time and focus film distance, the types, sensitivity and speed of films used and the placement and accuracy of TLDs.

Conclusion

The entrance surface doses (ESD) to the thyroid gland ranged between 0.11mGy to 3.92mGy with a composite mean ESD ± SD of 1.05±0.82mGy. There was no statistically significant difference between these means. The doses obtained in this study were lower than other documented doses however, due to stochastic biological radiation effects there is a need for a Diagnostic Reference Level (DRL) for intraoral radiography in Nigeria.

Recommendation

We recommend similar nationwide studies to set the diagnostic reference level for intraoral radiography in Nigeria.

Acknowledgements: The Authors will like to acknowledge the contribution of Dr C. Ohagwu for proof reading the original work and making very pertinent contributions. We also appreciate staff of Radiology unit of Living World Hospital for their support during the investigation.

References

1. Tolentino Ede S, Centurion BS, Ferreira LH, Souza AP, Damante JH, Rubira-Bullen IR. Oral adverse effects of head and neck radiotherapy: literature review and suggestion of a clinical oral care guideline for irradiated patients. J Appl Oral Sci. 2011; 19(5):448–454. doi:10.1590/s1678-77572011000500003
2. Williamson Gail. Intraoral Imaging: Basic Principles, Techniques and Error Correction https://www.dentalcare.com/en-us/professional-education/ce-courses/ce559/intraoral-radiographic-techniques. Retrieved 26th January 2020.
3. Azorín C, Azorín J, Aguirre F and Rivera T. Dose measurements in intraoral radiography using thermoluminescent dosimeters. Journal of Physics: Conference Series, Volume 582, Number 1
4. American Dental Association Council on Scientific Affairs. The use of dental radiographs: update and recommendations. J Am Dent Assoc., 2006; 137, 1304-12.
5. Foster Tom and Gaillard Frank. Thyroid gland https://radiopaedia.org/articles/thyroid-gland retrieved 10 December 2019
6. Robinson ED, Nzotta CC, Onwuchekwa I. Evaluation of scatter radiation to the thyroid gland attributable to brain computed tomography scan in Port Harcourt, Nigeria. Int J Res Med Sci 2019;7:2530-5.

© 2020 IJMSIR, All Rights Reserved

7. Rush, E.R. and Thompson, N.A. Dental radiography technique and equipment: How they influence the radiation dose received at the level of the thyroid gland. Radiography, 2007; 13, 214- 220.
8. Brenner, D.J., Doll, R., Goodhead, D.T., Hall, E.J., Land, C.E. & Little, J.B. Cancer risks attributable to low doses of ionizing radiation: assessing what we really know. PNAS, 2003; 100, 13761-6.
9. Zhang, Y., Li, X., Segar, W.P., Samei, E. Organ doses, effective doses and risk indices in adult CT: comparison of four types of reference phantoms across different examination protocols. Med Phys, 2012; 39(6), 3404-23.
10. Sheikh S, Bhoweer AK, Arya S, Arora G. Evaluation of surface radiation dose to the thyroid gland and the gonads during routine full-mouth intraoral periapical and maxillary occlusal radiography. Contemp Clin Dent. 2010; 1(2):83–87. doi:10.4103/0976-237X.68597
11. Natalia, O. M., Lucía, V.C., Claudia, L.P., et al. Assessment of Dose in Thyroid and Salivary Glands in Dental Radiology Using Thermoluminiscent Dosimetry. International Nuclear Atlantic Conference –INAC. 2011.
12. Rosenstein, M. Diagnostic reference levels for medical exposure of patients: ICRP guidance and related ICRU quantities. Health Phys. 2008; 9(5), 528-34.
13. Jibiri, N.N., Adeleye, B. and Kolude, B. Radiation dose to the thyroid, eyes and parotid glands of patients undergoing intra-oral radiographic procedures in a teaching hospital in Ibadan, Oyo state Nigeria. International Journal of Radiation Research, 2017; 1, 15.
14. Ogunseyinde, A.O., Adeniran, S., Obed, R.I., Akinlade, B.F., Ogundare, F.O. Comparisons of some X-ray examination with CEC reference doses. Radiatprot Dosimetry, 2002; 98, 231-4.
15. International Commission on Radiological Protection, ICRP. Recommendations of the International Commission on Radiological Protection, an ICRP Publication 103. 2007. Amsterdam. Elsevier.
16. Yamane, Taro. Statistics, An Introductory Analysis, 1967; 2nd Ed., New York: Harper and Row.
17. Mortazavi S.M.J., Ghaisinezhad M., Bakhshi M., Jafarizadeh M., Kavousi A., Ahmadi Kohanali Jafar, Shareghi A. Entrance Surface Dose Measurement On The Thyroid Gland In Orthopantomography: The Need For Optimization. International Journal Of Radiation Research. 2004; Volume 2 , Number 1; Page(S) 21 To 26.
18. Alcaraz M, Velasco F, Olivares A, Velasco E, Canteras M, Dose reference levels in spanish intraoral dental radiology: Stabilisation of the incorporation of digital systems in dental clinical practices, radiation protection dosimetry, 2016; volume 172, issue 4, pages 422–427, https://doi.org/10.1093/rpd/ncv508
19. González L, Vano E, Fernández R. Reference doses in dental radiodiodiagnostic facilities. British J. Radiology. 2001; **74** 153–156
20. Geijer, Håkan. Radiation dose and image quality in diagnostic radiology. ptimization of the dose-image quality relationship with clinical experience from scoliosis radiography, coronary intervention and a flat-panel digital detector. Acta radiologica. Supplementum, April 2002; 43(427):1-43 ·

© 2020 IJMSIR, All Rights Reserved